while in the second part is given some data not ordinarily available in regard to wind velocities.

There seems to have been but little detailed wind direction data published. In the Weather Bureau Bulletin Q, Climatology of the United States, by Prof. Alfred J. Henry, pages 68–70, are given tables for 20 stations in the United States, showing the monthly and annual percentages of winds from each of the eight principal points of the compass for the 10-year period 1894–1903. Tennessee and adjacent States are not represented directly, Cincinnati, St. Louis, New Orleans, and Savannah being the nearest surrounding stations for which data are published. It seemed, therefore, of interest to compile records (Table 1) for Nashville, where the exposure of wind instruments has been good during the greater portion of the records and especially for the years selected, viz., 1895–1904 and 1918–1924. The two periods were combined and averages in the table are for 16 to 17 years, a period long enough to give fairly stable means. The figure showing the annual relative prevalence of the different winds is based upon records for the same combined periods.

TABLE 1.—*Wind, average percentage of time from each direction, Nashville, Tenn.*[1]

	N.	NE.	E.	SE.	S.	SW	W.	N W.	Calm	Prevailing direction
January	8.6	9.1	8.5	10.9	16.2	12.2	12.2	20.6	1.1	NW.
February	10.8	9.6	6.8	9.6	14.8	11.8	10.6	25.2	0.6	NW.
March	10.1	10.6	7.5	13.2	20.5	9.9	8.8	18.4	0.8	S.
April	9.2	10.3	7.5	12.0	19.9	10.7	10.5	17.6	1.6	S.
May	9.1	11.4	9.2	11.6	14.8	14.9	11.0	15.6	2.5	NW.
June	9.0	11.4	6.7	10.4	11.0	16.8	15.8	16.4	2.5	SW.
July	8.1	10.1	6.5	10.5	12.4	19.2	16.2	15.8	1.0	SW.
August	8.6	11.1	7.1	11.2	12.2	16.8	15.5	15.8	2.2	SW.
September	10.5	13.1	9.6	11.9	12.7	10.9	9.6	17.9	3.8	NW.
October	8.9	13.7	7.2	14.1	14.4	10.0	10.2	17.8	4.1	NW.
November	10.0	11.2	6.5	14.2	16.4	9.6	12.2	18.6	2.4	NW.
December	8.4	9.2	7.1	12.3	17.6	13.9	12.7	17.5	1.3	S.
Year	9.3	10.9	7.5	11.8	15.2	13.1	12.1	18.1	2.0	NW.

[1] Compiled from records of self-registering instruments, period of 16–17 years (1895–1904, inclusive, and January, 1918, to April, 1924, inclusive).

WIND VELOCITIES

Some years ago investigation was made to determine the character of the wind movement at Nashville as shown in relative frequency of various velocities, or percentages of time the wind blows at stated velocities. The information was not published at the time. The results are now shown in Table 2.

It is necessary, of course, to consider the elevation of the instrument above ground and the other conditions of exposure in the use of all anemometer records. The exposure of the anemometer at Nashville has varied from a rather low elevation above ground during the early years to high during the last 15 years, During the period 1895–1904, which was used in the compilation of Table 2, the anemometer exposure was unchanged and the instrument was 134 feet above ground, with no high buildings near. This was a very good exposure at what might be called a medium height above ground. Following this period, the instruments were exposed on the roof of the Custom House annex for about five years, under unsatisfactory conditions, and in March, 1909, they were removed to the present location, where the anemometer is 191 feet above ground and where the wind movement registered is decidedly greater than at any previous location. No doubt the anemometer exposure of 1895–1904, height above ground being 134 feet, gives data more nearly representative of the wind movement as it affects buildings, trees, etc., than the present high exposure.

TABLE 2.—*Wind, percentage of time at stated velocities, Nashville, Tenn.*[1]

	Velocities, miles per hour:							
	0–5	6–10	11–15	16–20	21–25	26–30	31–40	41–50
January	40.8	34.0	16.0	6.2	2.0	0.7	0.1	0
February	33.8	39.2	18.8	6.7	1.5	0.2	0.2	0
March	29.8	36.3	21.1	9.0	2.8	0.8	0.1	0
April	33.3	38.1	19.6	6.5	1.9	0.5	0.1	0
May	48.4	36.1	12.4	2.7	0.1	0	0	0
June	53.8	35.5	8.6	1.4	0.2	0	0	0
July	57.3	34.9	7.5	0.5	0	0	0	0
August	64.0	30.6	4.9	0.1	0.2	0	0	0
September	57.8	31.5	9.4	1.0	0	0	0	0
October	57.5	29.3	9.8	2.7	0.5	0	0	0
November	48.4	30.7	15.4	4.5	0.7	0.1	0.1	0
December	40.5	36.7	16.5	4.6	1.1	0.7	0.1	0
Year	47.1	34.4	13.3	3.8	0.9	0.25	0.06	0

[1] From records of 10 years, 1895–1904, inclusive. Elevation of anemometer above ground, 134 feet; above sea level, 594 feet

In connection with both wind direction and wind movement, Table 3 is presented to show the average velocity of the wind from the eight principal points. This information was easily compiled from the data found on page 13, Form 1001, which was begun January 1, 1918. The record is for a period of only 6 to 7 years; however, it gives averages that may be fairly substantial. These are the first data showing relative strength of the winds from different directions that this station has prepared, and I can not recall any previously published data of just this character for other places.

TABLE 3.—*Wind, average velocity for each direction, miles per hour, Nashville, Tenn.*[1]

Stations	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sept.
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Mean
January	9.4	8.5	6.2	7.9	10.8	10.1	9.8	12.2	9.4
February	10.4	8.8	6.2	9.1	10.5	11.1	9.4	12.4	9.7
March	10.5	8.2	6.9	11.5	14.3	13.8	12.2	13.8	11.4
April	10.3	8.8	7.2	11.1	12.7	11.5	10.6	12.2	10.6
May	8.1	7.7	6.2	8.0	9.4	9.1	7.1	9.0	8.1
June	7.8	7.7	6.0	6.4	7.4	7.8	6.9	7.6	7.2
July	7.0	6.7	5.8	6.1	6.7	7.0	6.4	6.6	6.5
August	6.8	6.5	5.6	6.2	6.6	7.3	6.0	6.8	6.5
September	6.7	7.5	5.6	6.5	6.8	7.6	5.5	6.8	6.6
October	7.9	6.7	6.0	9.6	8.6	7.8	6.4	10.0	7.9
November	9.0	7.5	5.8	10.4	11.1	7.4	8.1	11.1	8.8
December	8.2	7.6	5.8	10.4	12.8	10.8	11.0	13.3	10.0
Year	8.5	7.7	6.1	8.6	9.8	9.3	8.3	10.2	8.6

[1] Compiled from records for the period January 1, 1918, to April 30, 1924 (6–7 years). Height of anemometer above ground, 191 feet; above sea level, 675 feet.

PHYSIOLOGICAL HEAT REGULATION AND THE PROBLEM OF HUMIDITY

628.8

By Prof. E. P. LYON, M. D., Dean of the Medical School, University of Minnesota

[Excerpts from paper read at the January, 1921, meeting of the American Society of Heating and Ventilating Engineers at Philadelphia, and published in part in The Heating and Ventilating Magazine, New York, Feb. 1921, pp. 43–45]

This paper discusses the heat regulation of the human body as an engineering problem and brings out the importance of humidity as external aids to this process.

The human body is a thermostat, the temperature of the body—that is, the internal parts—is constant. By constant is meant exactly what engineers mean when they say the temperature of a room with thermostatic control is constant. It really varies somewhat, and the small variations are made the basis of regulation.

The body is a machine for transforming energy. One aspect of this transformation is the developing and regulating of heat. The constant temperature of the body is an expression of the fact that the body loses heat as fast as it produces it, or produces heat as fast as it loses it.

* * * One gram of starch or fat will give in the body exactly as many calories as if burned in a bomb calorimeter, and the waste products are the same.

The more important element of body temperature regulation is, however, on the heat-loss side. The body loses heat in several ways. Usually it is warmer than the substances (air, especially) in contact with it. Therefore, according to the laws of physics, heat will be conducted as heat into neighboring matter. The rate of such transmission varies with the difference in temperature of the substances in contact; say, body surface and air. This difference in temperature may vary from the outside in a variety of ways. By use of a fan we can renew the layer of air frequently and thus increase temperature difference and heat loss. By clothing we can keep the layer of air in contact, raise its temperature, and diminish the rate of heat loss by conduction.

The rate of heat loss by conduction also depends on the heat capacity and conductivity of the material in contact with the skin. Moist air has a greater heat capacity than dry air of the same temperature. Hence at temperatures around the freezing point and somewhat above moist air "feels" colder than dry air of the same temperature. The moist air takes away heat from the skin faster; therefore, the skin is cooler. Conditions are very different at higher temperatures, where atmospheric humidity, by hindering evaporation, is a heat preserving factor for the body. Thus arises the anomaly that humidity may keep us warm or cool, depending upon the temperature of the air in which the moisture is held. * * *

The third way in which the body loses heat is by evaporating water. This occurs at both the skin surface and the lung surface. The rate of evaporation and consequently of heat loss varies with numerous factors. It increases with temperature of the air on the skin, and therefore acts, in general, opposite to conduction and radiation, which is a fortunate fact. Evaporation increases with increased renewal of air, consequently a fan or wind cools the body; as likewise does rapid breathing, except in so far as it increases the rate of oxidation. Evaporation rises with increase of the surface of liquid exposed. We expose more liquid surface when we sweat than when the skin is, as we say, "dry." Of course it is never absolutely dry, and insensible perspiration is constantly being evaporated.

By the three methods mentioned, namely, conduction, radiation, and evaporation of water, the body loses practically all the heat that it produces. All of these vary in rate with external and internal conditions. All of them become ineffective under conditions of combined high temperature and high humidity.

Various external factors have been referred to, that affect the rate of heat loss by the three methods of conduction, radiation, and evaporation. The body from its side is not passive. It has two ways of accomodating or adjusting itself to the three methods of heat loss and thus keeping a constant temperature. The first is by distribution of the blood. When the outside temperature is hot, much blood is sent from the internal parts to the skin. The skin temperature is raised by this warm blood and the rate of heat loss by conduction and radiation is increased. When the outside temperature is low, little blood is sent to the skin and less heat is lost by conduction and radiation.

The second method of internal adjustment is the sweat secretion. This liquid, which is practically nothing but water, is extracted from the blood by coiled tubes, called sweat glands, located in the skin. When the temperature is high the amount of secretion increases; the liquid surface to the air increases; evaporation increases; the heat loss increases; and the temperature of the body falls. * * *

Man adjusts himself to every degree of atmospheric moisture from the practically absolute dryness of subzero air to the saturated air of tropical forests. Humidity is of little importance except when considered in connection with other conditions, particularly temperature and air movement.

I advocate strongly the artificial humidification of dwelling houses in winter in our northern States. The standard should be as high as can be secured without precipitation on inside walls. I do not think we can go above 50 per cent in our houses, as ordinarily built, even with double windows.

On account of leakage the amount of water to be evaporated is large; say 15 or 20 gallons a day for a small house. Therefore, the devices on the market, to be used on radiators, are all absolutely inefficient. Tests show that few of them evaporate as much water as one person gives off from his lungs. Most of the devices used in connection with hot-air furnaces are of little real use.

The problem can be solved, but it requires special attention to certain factors of evaporation, namely, surface of contact of water and air and movement of air. These are more important under house conditions than temperature. * * *

As a matter of opinion I may say that some type of humidifier by which air movement would be created, e. g., a combination of electric fan and convenient water surfaces, would be the ideal. Why should not people be willing to pay for humidity and air movement, two important hygienic factors?[1]

The most usual condition under which the body-heat control breaks down is high humidity and high temperature combined. This condition obtains in crowded rooms and auditoriums, because every person gives off both heat and water vapor. Such rooms need, primarily, new and moderately heated air. Movement of air also helps. Movement under extreme conditions, for example, saturated air of body temperature, would not help heat loss at all, but under usual conditons and for reasons already given it does help.

Movement of air in our public places and homes should be worked for. If we become accustomed to air in motion, we are less affected by outside conditions, where such movement is the rule. We ought to be accustomed to drafts and not affected by them. I shall not be surprised if we come to use electric fans in winter, even more than in summer.

The greatest problem from the standpoint of humidity is the home or office, where a few live and work, in winter in our northern States. We take into our house subzero air which has almost no water content and heat it to 70° F. Even with the water which such air eagerly laps up from furniture, plants, cooking processes, and from the skin and lungs of every occupant, nevertheless this air in our homes is likely to be drier than that of any desert on earth.

[1] Some of this expense would be off set by the saving in fuel because properly humidified air does not need to be at such high temperatures for comfort.—EDITOR.

The body thermostat can adjust the temperature of the internal organs to these conditions. There is not such discomfort and danger as comes from overcrowded, unventilated movie theaters or school-rooms. But there are somewhat important disadvantages.

In the first place, in order to keep up the body temperature in dry air, much blood is withdrawn from the skin. Moreover evaporation is active. The skin is cooled, and we "feel chilly." Hence the tendency is to have hotter rooms, up to 75° to 80°, and even 85° F. The skin gets cracked and rough, which is not pleasant to say the least. The same tendency to rapid drying extends to the mucous surfaces of the nasal passages, the pharynx and trachea, with consequent respiratory disturbances. Nose and throat specialists, generally, attribute the frequency of infections in winter more to the dryness than to the cold. This amounts to saying that in order to protect its indispensable internal temperature, the body has to abandon more or less the outlying provinces such as the skin and mucous surfaces. They have not enough blood and get dry; they pick up germs and become inflamed. * * *

551.524 (73)

THE UNSEASONABLE WEATHER OF MAY, 1924

By ALFRED J. HENRY

It was the privilege of the writer to contribute to this REVIEW some account of the cold spring of 1907.[1]

The present spring resembles in several, though not all respects, that of 1907, and since it affords an opportunity to attempt to correlate the weather in the United States with that of other portions of the Northern Hemisphere some space will be given to that end.

May is a month when normally in the Northern Hemisphere temperature should rise; it is well known, however, that the temperature in that month in some years, but not in all, suffers interruptions of greater or less duration and intensity, thus the temperature instead of rising sinks materially and sometimes continues at a low point for a week or 10 days. When these interruptions are more or less continuous over a considerable time the result is a cold and backward month such as occurred in north-central and northeastern United States in May, 1882, in practically the whole country in 1907 and 1917, and in a less degree in the month here under discussion. This phenomenon has been recognized for more than 100 years and in the meantime a very considerable literature thereon has been developed.[2]

In the last 40 odd years May was exceptionally cool east of the Rocky Mountains in 1882, 1883, 1888, 1890, 1907, 1917, and 1924.

Cool weather in May is due to several causes operating singly or in conjunction. The first and chief cause apparently has its origin in the polar regions and is manifest in temperate latitudes of both hemispheres by an unusual flow of cold polar air toward the equator; as a direct result of such flow masses of cold and warm air, respectively, are brought into contact, vertical and horizontal convection produces condensation and much cloud and rain. Insolation is, therefore, hindered and thus contributes to a lowering of the temperature, or shall we say prevents the normal increase in temperature due to the incoming solar energy. May, 1924, in northeastern United States was exceptionally cloudy and rainy. While the rainfall here in Washington was not exceptionally heavy, it was nearly continuous after the 12th. From that date until the close of the month the greatest interval of fair weather did not exceed two days.

THE WEATHER OF PREVIOUS COOL MAYS

May, 1882.—In the United States this month was characterized by low temperature, the lowest in 40 years or more in northeastern districts; heavy rains in the Ohio Valley; much ice in the region of Newfoundland, also on the coast of Nova Scotia, the harbor at Halifax being ice-bound in the last decade of the month. Outside of the United States the only observational data available are those contained in the Signal Service International Bulletin. That publication contains monthly means of pressure, temperature, and wind direction for one station each in the Faroes, Iceland, and Greenland. From these data it is established that pressure in the Arctic was above normal with polar winds (from the pole); the Icelandic minimum was centered to the southwest of that island, approximately in north latitude 55°, West longitude 20°. The Azores maximum was likewise to the southwest of its usual position. In the British Isles both pressure and temperature were above normal, the former by 0.04 inch and the latter by 3. Temperature was less than normal in the Azores and quite generally throughout Iceland, Norway, Spain, Italy, and Portugal and points in the Black Sea region.

The paths of anticyclones in the United States show clearly the movement of masses of cold air over the Canadian Maritime provinces and fully explain the pressure abnormality of plus 0.30 inch at St. Johns, N. F. The origin of these disturbances was apparently north of the Great Lakes, especially in the region of Hudson Bay.

May, 1907.—The observational data for this month, although greater than for 1882, are lacking almost entirely for northern Canada and Alaska.

The writer in discussing the cold spring of that year[3] attributes the unseasonable weather to the pressure distribution over the North American Continent in consequence of which the intrusion of masses of cold air by way of the upper Missouri Valley were greatly facilitated.

In Northwestern Europe after the middle of the month there was a greater or less influx of cold polar air, as witness the following excerpt from Weekly Weather Report, London 1907, p. 164.

"High pressure in Iceland and off the west coast of Europe and low pressure over central Scandanavia established a gradient for northerly winds over the British Isles and indeed from the Arctic to the Mediterranean. Low temperature for the season prevailed generally over Europe practically to the close of the month."

No information relative to the ice about Newfoundland is available but the pressure at St. Johns N. F. was 0.14 inch below the normal, directly the opposite of that for May, 1882, when, as before stated there was much ice at that place.

May, 1917.—An account of the cold weather of this month will be found in this REVIEW for June 1917.[4] The exceptional character of the weather of that month was the low temperatures that prevailed in *all parts of the country*, the absence of extremely low minima, the lack of sunshine and consequently the failure of the day temperatures to reach the usual high values.

[1] Henry, A. J. The cold spring of 1907, MO. WEATHER REV. 35: 223-25.
[2] Cf. this REVIEW 47: 555-65.
[3] Loc. cit.
[4] Day P. C The cold spring of 1917; 45: 285-89.